

## Brief Communication: Prehistoric Dentistry in the American Southwest: A Drilled Canine From Sky Aerie, Colorado

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**ABSTRACT** A prehistoric Native American mandible from a Fremont site (circa AD 1025) in Colorado has a conical pit in the worn occlusal surface of the lower right canine. Natural causes for this modification are ruled out by the presence of internal striae, a finding confirmed by experimental replication. The canine was artificially drilled before the individual's death and is associated with a periapical abscess. This is one of a very few examples of prehistoric dentistry in the world, and the first from the American Southwest. *Am J Phys Anthropol* 103:409–414, 1997. © 1997 Wiley-Liss, Inc.

An unusual occlusal perforation was observed in a permanent canine during the analysis of an osteological assemblage from prehistoric Colorado. While extensive dental mutilations for decorative purposes are known from Native American sites (Milner and Larsen, 1991), particularly in Central and South America (Romero, 1970), the modification of the Colorado specimen differs from those by being located occlusally rather than labially. Given the paucity of reports of prehistoric dentistry (Milner and Larsen, 1991), we investigated the possibility that this modification was artificially induced and therapeutically motivated.

### CONTEXT

The Sky Aerie Overlook site (5RB 104) is a prehistoric Formative Stage Fremont promontory household site situated on top of and around the east base of a prominent erosional sandstone outlier on the eastern margin of the Uintah Basin in Rio Blanco County, Colorado. The site is hallmarked by an

extensive, dark, classic midden deposit which is spilling from the bedrock because of vandalism and erosion. Limited archaeological excavations were undertaken by Centuries Research in October 1993 to determine the degree of previous vandalism, remediate the obvious damage, and evaluate the archaeological potential of the site. The field program was prompted by nearby natural gas exploration activities and involved constrained excavations designed to evaluate the site's content and potential to contribute to local Fremont and Numic directed archaeological studies (Baker, 1993).

A total of eight 1-m square units were dug to bedrock within the undisturbed and partly disturbed portions of the site. Excavation revealed the living surface of the interior of

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Fig. 1. The partially excavated bone bed at the Sky Aerie Promontory (5RB 104), with mandible 2-32 exposed at the tip of arrow A. The view is to the southeast with the larger scale marked in 50 cm increments (photo of 24 October 1993 by SGB courtesy of Centuries Research, Inc.).

a Fremont house constructed directly on sandstone bedrock, with bedrock postholes and a clay-rimmed hearth. Within the hearth were remains of various fragmented human skeletons, including three disarticulated skulls, covered by a layer of clay forming a mound over the hearth. Excavation of the floor of the house yielded a bone bed consisting of disarticulated human skeletal remains, with minor amounts of large and small nonhuman mammal bone. The minimum number of human individuals recorded from the partially excavated site is nine.

Tim White and Silvia Cornero undertook analysis of the bone modification on this unusual, disturbed skeletal collection in an effort to understand its origin. Contextual data demonstrate that the bodies had been mostly disarticulated prehistorically. No evidence of perimortem modification was found besides burning on some elements. It did not show the "signature" interpreted in other southwestern osteological assemblages as indicating cannibalism (White, 1992). The lack of culturally induced surface modification on the bones suggests that some disassociation might have occurred during disturbance of the grave sites by later occupants.

Additional work is required to establish how these disarticulated bones came to rest.

Sky Aerie appears to be associated with a localized expression of the larger Uintah variant of the Fremont Culture (Marwitt, 1970). This localized version is common on the Douglas Creek Arch, and is often referred to as the "Douglas Creek Fremont" (Cassells, 1983; Creasman, 1981). One radiocarbon date (Beta-84207) has been obtained from charred seeds recovered from ashy occupational fill adjacent to and within the hearth. The sample materials were directly associated with the occupation of the structure and at least some of the human skeletal remains. The sample returned a conventional radiocarbon age of  $1040 \pm 70$  BP and a two sigma calibrated range of AD 880 to 1170. This date range places the occupation well within the generally accepted minimal Fremont Culture time frame of circa AD 600 to 1200 (Creasman, 1981).

The specimen being investigated is an adult mandible, Catalog no. 32 from Analytical Unit no. 2, the bone bed of Quad 1, F.S. 15 (1-2S, 3-4.5W; Fig. 1). A minimum of eight individuals are represented in this bone bed, based on four other adult mandibles, two juvenile mandibles (aged  $5.0 \pm 1.5$  and

8.0  $\pm$  2 years; Ubelaker, 1989), and remains of a perinatal individual. It is not currently possible to reassociate mandible 2-32 with any of the other specimens from the site. All of the remains were judged to be Native American on the basis of antiquity, associated artifacts, bony features, and dental wear.

## RESULTS

The mandible (2-32) is well preserved, but lacks the incisors and the right third molar. All teeth present were in the mandible when it was uncovered in the excavation. The right canine was loose in its alveolus, but is clearly a lower right canine based on its morphology and antimeric correspondence with the firmly embedded lower left canine. The dentition is typically and heavily worn, with complete occlusal dentin exposure on the premolars and first two molars. There is a periapical abscess centered below the tip of the right canine root (Fig. 2A,B). The limits of the lesion are obscured by postmortem damage, but it was clearly large. A second abscess is visible at the left lateral incisor alveolus (Fig. 2B). The right canine's occlusal surface measures 8.1 mm in labiolingual diameter, including the thin rim of remaining enamel.

There is a perforation centered on the occlusal surface of the right canine of specimen 2-32 (Fig. 2A-D). The perforation is conical in shape, with the tip of the cone pointing rootward. The long axis of the cone is perpendicular to the alveolar plane. The perforation measures 3.5 mm in maximum diameter at the occlusal surface. It ends about 3 mm below the occlusal surface, where it is confluent with the pulp chamber as seen in occlusal view and in periapical radiographs. The walls of the conical hole are marked by dense, mostly parallel, circumferential striae (Fig. 2C,D). These striae are irregular in depth, imparting a "stratified" appearance to the walls of the hole. The fact that the striae are truncated obliquely by occlusal attrition (Fig. 2C) indicates that the individual continued to chew on this tooth after the hole was formed. Virtually all drilled holes in prehistoric teeth, whether decorative or therapeutic, are reported to have circumferential striations on their walls

(Bennike, 1985; Gwinnett and Gorelick, 1979; Hanson, 1988; Milner and Larsen, 1991). An exception is the specimen described by Schwartz et al. (1995).

The hole is clearly related to human intervention. There are other deep, vertically walled perforations in the Sky Aerie dental assemblage, but none show the clear symmetry, conical cross-section, or concentric rings associated with the hole in the canine of mandible 2-32. The other perforations demonstrate morphology typical of carious dental lesions. The striae indicate that some kind of mechanical, rather than chemical, agency was responsible for the formation of the hole in the canine. Taphonomic factors, such as rodent gnawing, can be ruled out because the perforation is symmetrical, located in the crown's center, and runs deep to the occlusal surface. The only cause for such a hole consistent with the observations is some form of drilling.

In an effort to replicate the hole in the Sky Aerie canine with materials available prehistorically, we hafted a sharp flake of obsidian to the end of a wooden rod approximately 1 cm in diameter. A lower human canine exhibiting a wear pattern similar to the Sky Aerie canine was removed from our laboratory collection. We then inserted the sharp tip of the obsidian flake into a slight depression on the occlusal surface of the canine. By twisting the rod rapidly in a drilling motion, palms together on the shaft of the drill stick, we were able to quickly drill a conical hole (Fig. 3). Both the canine tissue (old dentin) and drill material (sharp obsidian) were very brittle, but we were still able to mimic experimentally what we saw on the prehistoric canine. The experimental hole features irregular, circumferential striations on its walls just like those in the prehistoric specimen. The experimentally drilled tooth also shows an extensive series of microfractures radiating from the hole, which are presumably due to the brittle nature of the nonliving tooth. Such cracking is absent in the Sky Aerie canine, probably because the tissue is less brittle in the living individual.

The results of our experimental trial are consistent with previous such attempts. Bennike (1985) was able to replicate an artificial hole found in a Neolithic Danish molar by

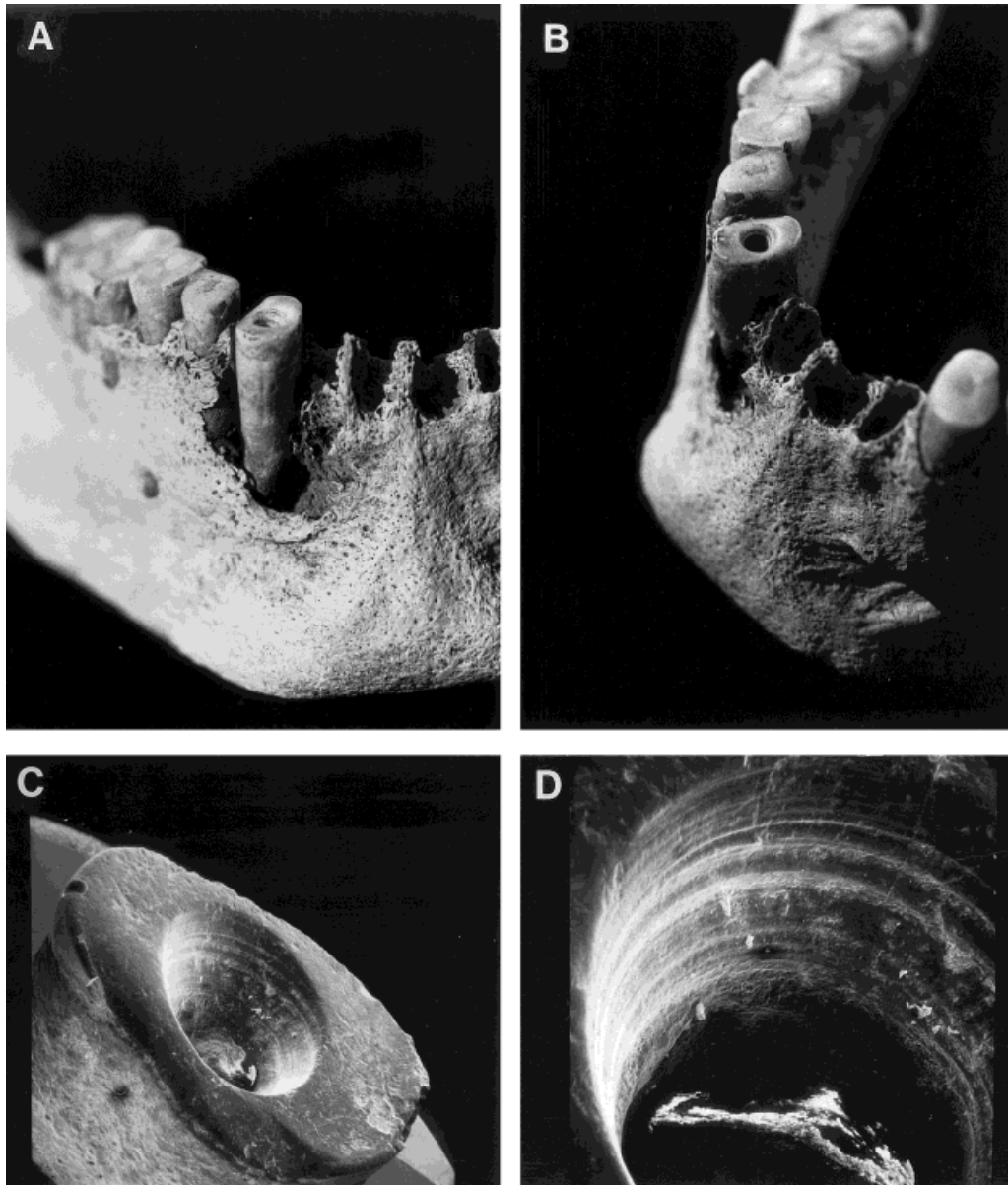


Fig. 2. **A:** Anterolateral view of Sky Aerie mandible showing drilled canine and periapical abscess (partially obscured by postmortem damage). **B:** Anteromedial view of Sky Aerie mandible. **C:** SEM of Sky Aerie occlusal surface (8 $\times$ ). **D:** SEM of Sky Aerie hole interior (40 $\times$ ).

using a reconstructed bow drill. Bennike also examined the morphology of a drilled amber bead recovered from the same site. The scanning electron micrographs (SEM) of the holes in the Neolithic Danish tooth and bead, Bennike's and our experimental teeth, and the Sky Aerie specimen are all remark-

ably alike. They are also quite similar to the SEM of holes drilled for decorative fillings in prehistoric Mayan teeth and modern replicas produced with wooden and flint drills (Gwinnett and Gorelick, 1979). This work, in combination with our own replication experiment, indicates that a prehistoric

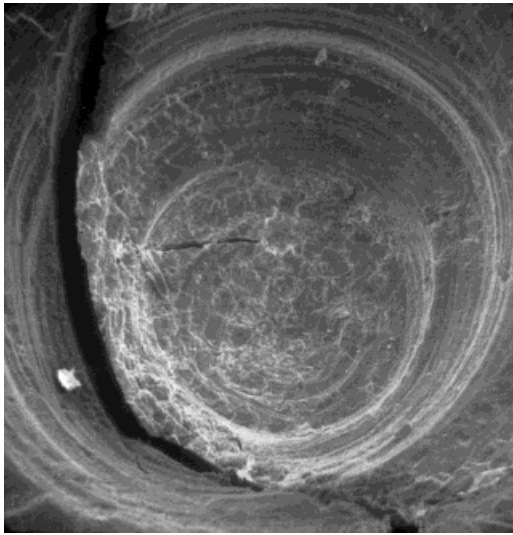


Fig. 3. SEM of experimental hole interior (40 $\times$ ). Microfractures are probably due to the brittle tissue of this nonliving tooth.

stone-tipped drill, probably rotated with a bow or between the driller's palms, produced the hole observed in the Sky Aerie specimen.

It is not possible to determine with certainty the motivation for drilling the canine of Sky Aerie specimen 2-32. It is unlikely to have been done for decorative purposes, as occlusal modifications would not be visible to others and ornamental inlays have been reported only for the labial surfaces of teeth (Milner and Larsen, 1991; Romero, 1970). The presence of a large periapical abscess associated with the drilled canine suggests a therapeutic motivation, and also indicates that there may have been a preexisting carious lesion. We suggest that there was an occlusal carious lesion on the canine which was drilled out, with the resulting hole obliterating the caries. While the abscess could have been caused by the drilling, most decorative dental modifications (prehistoric and modern) are not associated with subsequent abscesses or caries (Milner and Larsen, 1991). The presence of an occlusal carious lesion provides an initial depression which would facilitate drilling and the confinement of any abrasive used (Gwinnett and Gorelick, 1979).

## DISCUSSION

A number of prehistoric dental modifications have been reported, as reviewed by Milner and Larsen (1991). The vast majority of these appear to have been for decorative purposes, such as the ornamental inlays and filing found in Central and South America (Romero, 1970). Our review of the literature found only six cases of prehistoric dental modifications ascribed to a therapeutic motivation. Two of these cases are dubious. A carious lesion in a prehistoric specimen from Illinois is said to have been hollowed out based on the interior surface morphology, but no abrasions were noted and no other supporting evidence is offered (Koritzer, 1968). Gibson (1971) studied another specimen from the same location that has two cavities in the buccal-cervical region of the right mandibular canine and third premolar. These cavities were evidently filled with some type of calcium carbonate, and St. Hoyme and Koritzer (1971) interpret this as evidence of dental filling for therapeutic purposes. However, Gibson (1971) argued that the filled cavities were of mechanical origin based on the morphology of the cavities, especially as seen in cross-section. The numerous photographs show these cavities to be of a shape unlike those caused by caries. Rather than carious lesions being filled for therapeutic purposes, these are more likely intentionally formed cavities. Decorative grooves and notches have been reported for teeth from this area and time (Milner and Larsen, 1991). A decorative intent would better explain why the several carious lesions in the posterior dentition of this specimen went unfilled.

Schwartz et al. (1995) report a specimen from Point Hope, Alaska, whose left mandibular central incisor has a drilled hole along with a depression in the labiocervical region. The tooth has an incisal carious lesion and a periapical abscess, and they tentatively suggest that it is an example of prehistoric dentistry. Bennike (1985) describes a Neolithic Danish specimen containing a right maxillary second molar with a drilled hole through the union of the buccal roots, as well as chiseling at the contact with the first molar. The morphology of the perfo-

ration is quite similar to that of the Sky Aerie specimen. Both molars had caries, and the drilled molar is associated with a periapical abscess. There is also an undescribed canine from the Mississippian period of Illinois with a circular perforation at the labial cervicoenamel junction of the left maxillary canine (Milner and Larsen, 1991).

Except for the Sky Aerie canine, the only other prehistoric specimen with drilling of an occlusal surface that has come to our attention is the individual discussed by Hanson (1988) from Rota, Mariana Islands. Both left canines in that individual have conical-shaped holes on the occlusal surface just lingual to the cusps. Occlusal wear is minimal, and the holes are mostly within the enamel. The holes are about 1.5 mm in diameter and range from 0.5 to 1.5 mm in depth, and so are significantly smaller than those in the Sky Aerie specimen. There is no evidence of filling material or caries at the canines, but there were carious lesions in both lower third molars. Since no photographs or drawings of the specimen were published, more detailed comparisons between the Rota and Sky Aerie modifications are not possible.

### CONCLUSIONS

The Sky Aerie specimen is one of the strongest pieces of evidence of prehistoric dentistry in the New World, and is the first reported for the American Southwest. It and the Rota specimen (Hanson, 1988) appear to be the only prehistoric individuals with occlusal drilling-type modifications. While the number of cases of possible prehistoric dentistry is currently too small to draw any general conclusions, it does appear that prehistoric peoples did attempt to ameliorate dental pathologies in at least a few instances. The frequency of such attempts, the precise methods used, and their cultural significance can only be evaluated if and when more examples are located and described.

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### LITERATURE CITED

- Baker SG (1993) The 1993 archaeological evaluation and vandalism study at the Sky Aerie Promontory (5RB 104), Rio Blanco County, Colorado: Initial field debriefing. CR Project No. 486, Chandler Douglas Creek Arch Series, Report No. 76, Manuscript, Centuries Research Inc., Montrose, Colorado.
- Bennike P (1985) Paleopathology of Danish Skeletons. Copenhagen: Akademisk Forlag.
- Cassells ES (1983) The Archaeology of Colorado. Boulder: Johnson.
- Creasman SD (1981) Archaeological Investigations in the Canyon Pintado Historical District, Rio Blanco County, Colorado. Unpublished M.A. thesis, Department of Anthropology, Colorado State University, Fort Collins.
- Gibson HL (1971) Multi-spectrum investigation of prehistoric teeth. *Dent. Radio. Photog.* 44:57-64.
- Gwinnett AJ and Gorelick L (1979) Inlayed teeth of the ancient Mayans: A tribological study using the SEM. *Scanning Electron Microsc.* 1979(II):575-580.
- Hanson DB (1988) Prehistoric mortuary practices and human biology. In BM Butler (ed.): *Archaeological Investigations on the North Coast of Rota, Mariana Islands*. Micronesian Arch. Surv. Report No. 23, Southern University at Carbondale, Center for Arch. Inv., Occ. Paper No. 8, pp. 375-435.
- Koritzer RT (1968) Apparent tooth preparation in a Middle Mississippi Indian culture. *J. Dent. Res.* 47: 839.
- Marwitt JP (1970) Median Village and Fremont Culture Regional Variation. University of Utah Anthropological Papers, No. 95.
- Milner GR and Larsen CS (1991) Teeth as artifacts of human behavior: Intentional mutilation and accidental modification. In MA Kelley and CS Larsen (eds.): *Advances in Dental Anthropology*. New York: Wiley-Liss, pp. 357-378.
- Romero J (1970) Dental mutilation, trephination, and cranial deformation. In TD Stewart (ed.): *Handbook of Middle American Indians*, vol. 9. Austin: University of Texas Press, pp. 50-67.
- Schwartz JH, Brauer J, and Gordon-Larsen P (1995) Brief communication: Tigaran (Point Hope, Alaska) tooth drilling. *Am. J. Phys. Anthropol.* 97:77-82.
- St. Hoyme LE and Koritzer RT (1971) Commentary on prehistoric dentistry. *Dent. Radio. Photog.* 44:65.
- Ubelaker DH (1989) *Human Skeletal Remains: Excavation, Analysis, Interpretation*, 2nd ed. Washington, D.C.: Taraxacum.
- White TD (1992) Prehistoric Cannibalism at Mancos 5MTUMR-2346. Princeton, Princeton University Press.